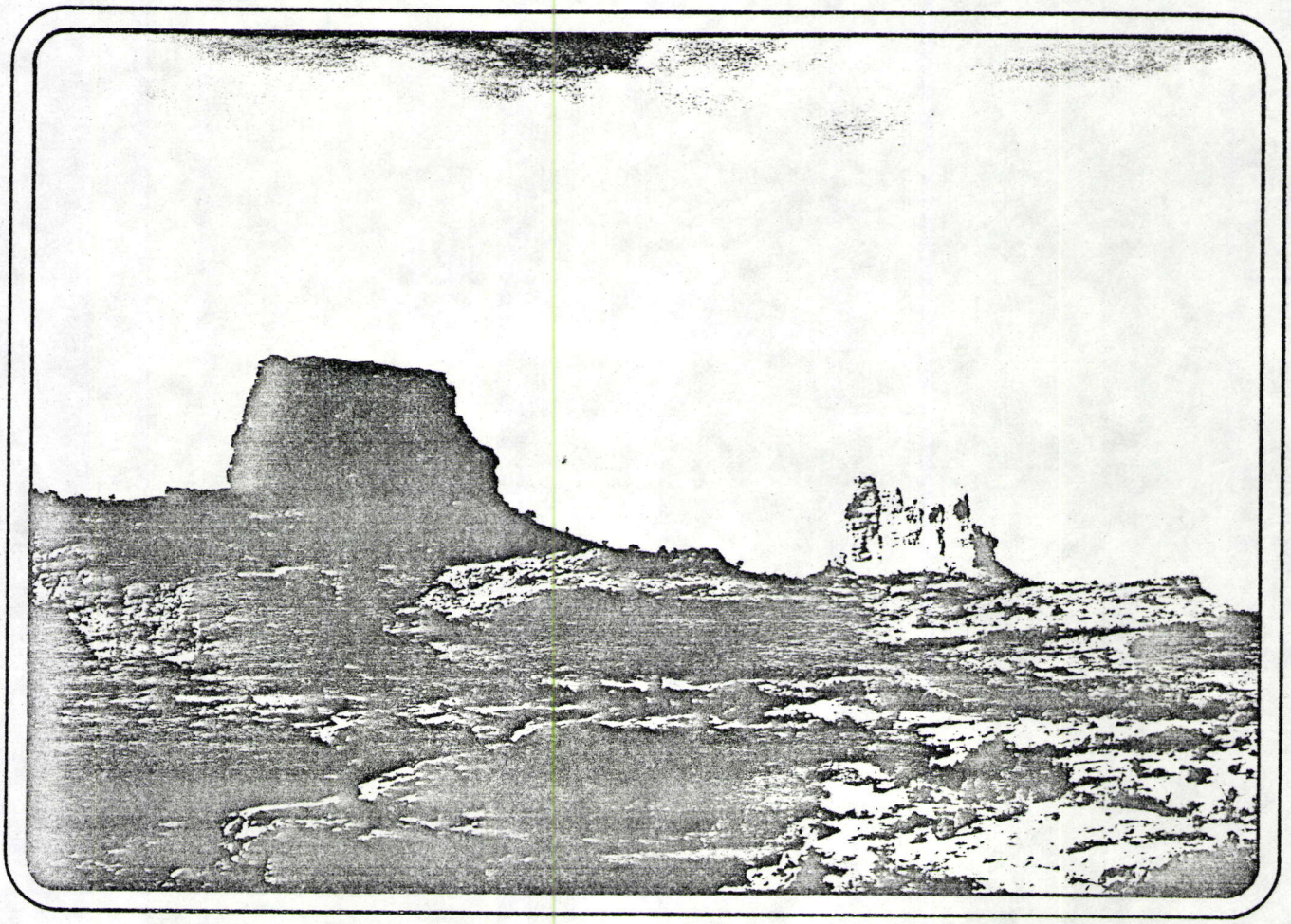
ACT/047/017

WHITE RIVER SHALE OIL CORPORATION



WHITE RIVER SHALE PROJECT

SITE VISIT

WHITE RIVER SHALE OIL CORPORATION

SUITE 500 PRUDENTIAL BUILDING, 115 SOUTH MAIN STREET
SALT LAKE CITY, UTAH 84111
(801) 363-1170

WHITE RIVER SHALE PROJECT

OVERVIEW AND OUTLOOK

March 1983

The White River Shale Project is owned by Phillips Petroleum Company, Sohio Shale Oil Company and SUNOCO Energy Development Co. and involves the development of Federal Prototype Oil Shale Leases Ua and Ub. These two tracts were leased from the federal government in 1974 for a total bonus bid of $120.7 million. The two tracts are located in Uintah County, Utah approximately 45 miles southeast of Vernal, Utah and are estimated to have recoverable reserves of over 700 million barrels of oil.

In additional to bonus payments, the owners of the project have spent another $60 million on development activities including the completion of plant access roads, construction of mine services buildings and facilities and the initial phase of a mine development program. In addition to these on-site activities, the owners have obtained the rights to use Union Oil Company's technology for extracting oil from shale and are currently proceeding with engineering and cost estimating efforts.

The current phase of the mine development program will include the completion of a mile-long production decline and a thirty-foot diameter, 1,000 foot deep mine ventilation shaft. As of March 1, 1983 approximately 800 feet of the production decline had been completed and work was proceeding at a rate of about 100 feet per week. At that same time work on the ventilation shaft was beginning. The shaft is planned for completion in the Spring of 1984 and the decline is planned for completion in the Fall of 1984.

Surface construction relating to oil shale retorting is currently planned to begin in 1986. Surface facilities will include material handling systems, retorts, crude shale oil upgrading facilities and utilities. Processed shale will be disposed of on the surface in an on-tract canyon. This material will be compacted, contoured and revegetated with native plants to its current level of productivity.

The current project schedule would result in oil production from the first phase of development in 1988. Full operation of this modular facility is planned to involve a 27,000 ton per day mine and an upgraded shale oil production rate of about 15,000 barrels per day in 1989.

If successful with this phase, plans are to expand the facilities in continuing phases which have a potential to produce 106,000 barrels per day by 1996. This production rate compares with a total refining capacity in the State of Utah of approximately 170,000 barrels per day. The commercial mine required to support this production rate would produce approximately 175,000 tons of ore per day. This rate compares with a rate of about 106,000 tons of ore per day at Utah's copper facilities and a rate of about 30,000 tons per day for all of Utah's coal industry.

Requirements for an Environmental Impact Statement have been satisfied by the Department of Interior's 1973 Environmental Impact Statement for the Prototype Oil Shale Leasing Program. The project has obtained the major permits required for development activities through 1985, and is in the process of obtaining additional permits for construction activities beyond 1985 and for subsequent operation. In March 1982 the Detailed Development Plan was approved by the Oil Shale Office of the Department of Interior. The Prevention of Significant Deterioration air quality permit covering the full 106,000 barrels per day facility was obtained in August 1982 from the Utah Bureau of Air Quality. Thorough analysis of the environmental impact of the project indicate that the predicted effects on environmental resources can be satisfactorily mitigated. A long-range monitoring program is planned to evaluate the project's environmental effects.

The combined construction and operations workforce for the first phase (15,000 barrels per day) is projected to peak at about 1,700 people with an operating workforce of about 850 people following construction. The combined construction and operations workforce for the full facility (106,000 barrels per day) is projected to peak at about 5,100 people with an operating workforce of about 3,350 people following construction. The permanent population growth associated with the full facility is projected to be about 13,000 one year after completion.

To help minimize the socio-economic impacts of construction, a construction camp is planned on-tract to house a majority of the construction workforce. The operations workforce will be stable over a long period of time and is expected to be assimilated into local communities.

The project has conducted comprehensive baseline and growth impact analyses in cooperation with state and local officials. These studies will assist in the development of timely and appropriate impact mitigation programs designed to minimize adverse impacts. A continuing monitoring program is in place to assist in assessing the impacts that have occurred and to assess the success of mitigation programs. As a result of bonus bid payments, the State of Utah received approximately $48 million in January 1982. These funds are presently being used throughout the state to alleviate the socio-economic impacts associated with energy development. Approximately $12 million of these funds has gone to the Uintah Basin area.

Oil shale as an industry faces many challenges as it develops into a significant supplier of domestic energy. The White River Shale Project is taking steps to contribute positively to the development of the commercial industry by advancing the state of knowledge in mining, processing and handling of oil shale and its related products in an environmentally responsible manner.

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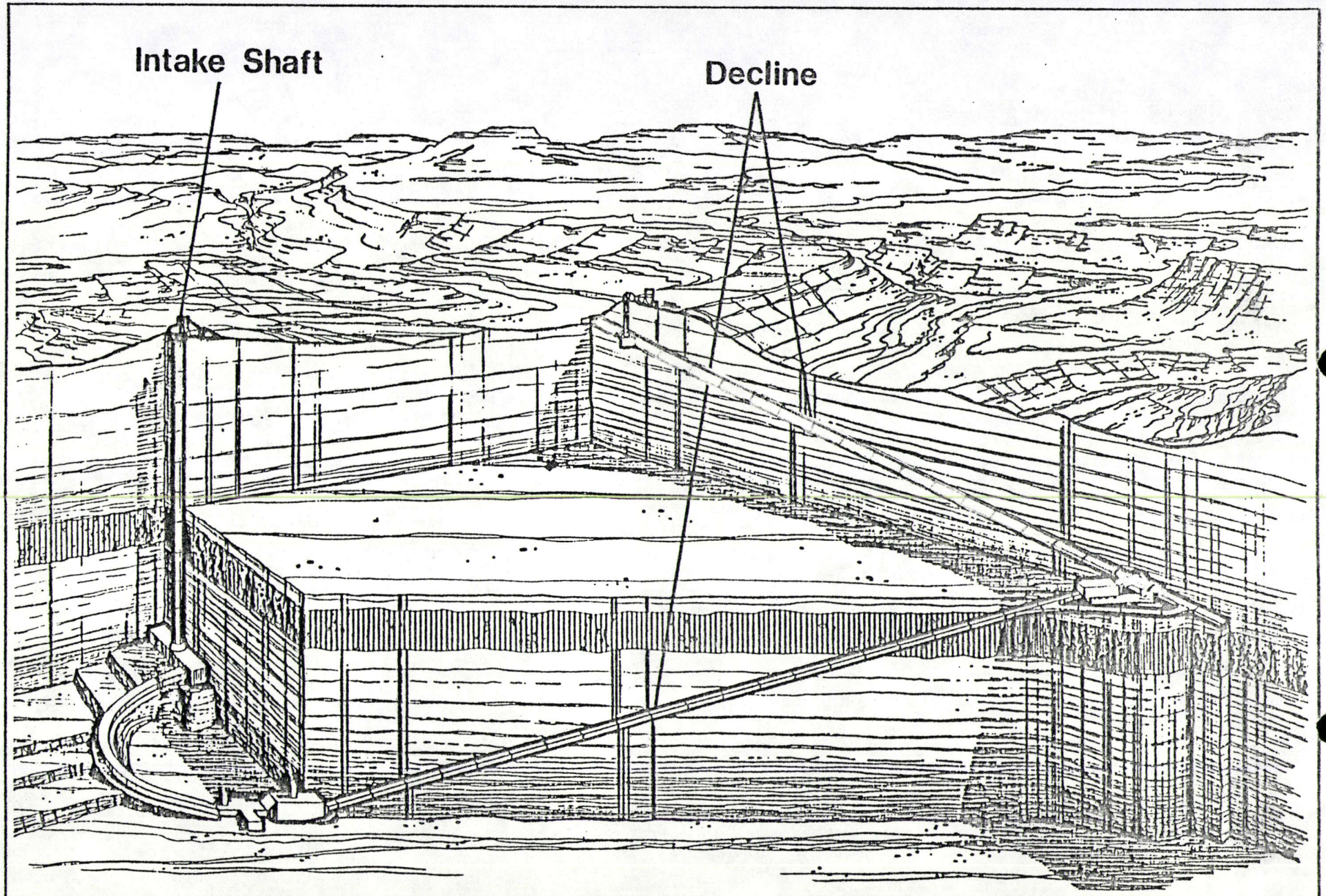
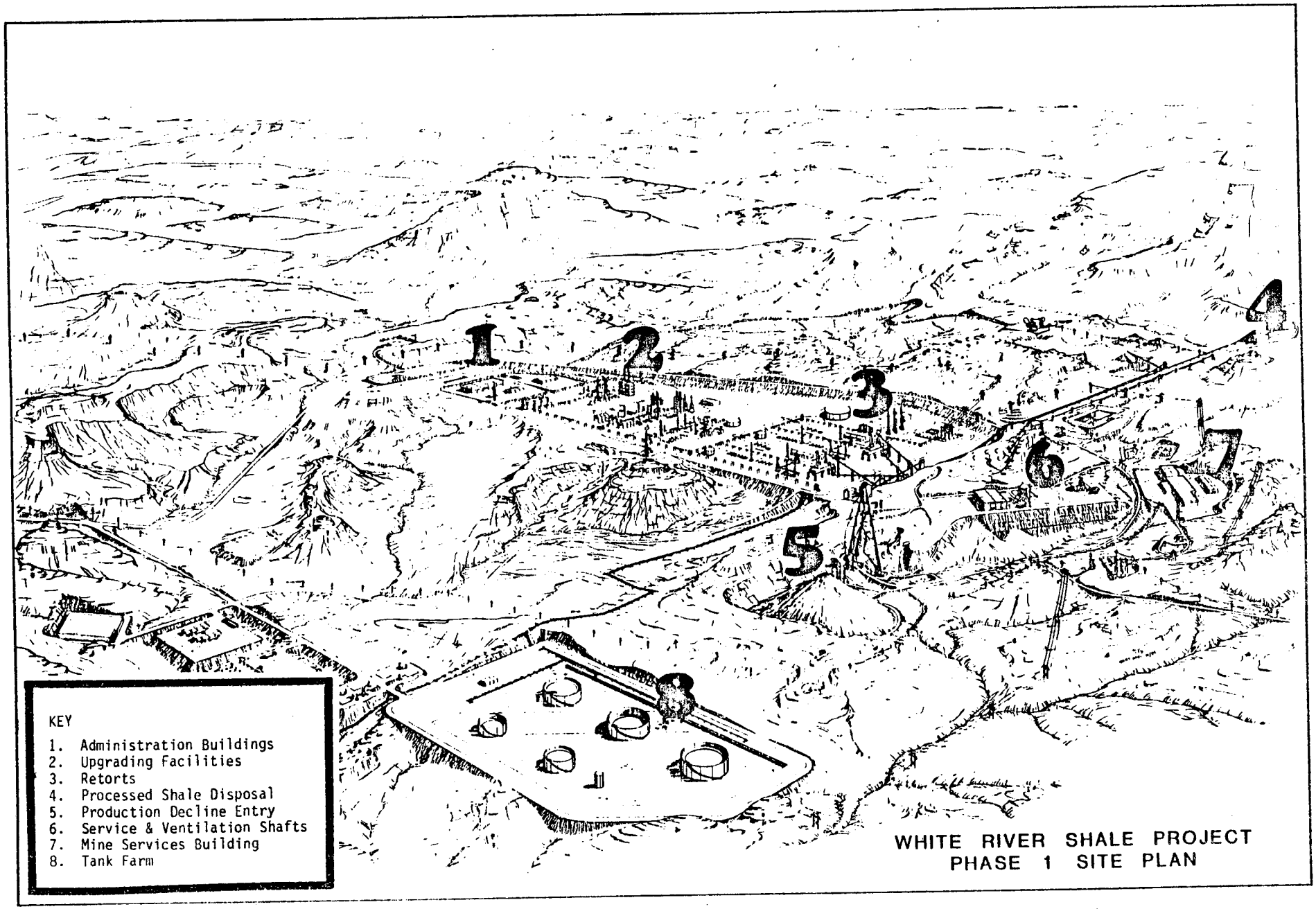
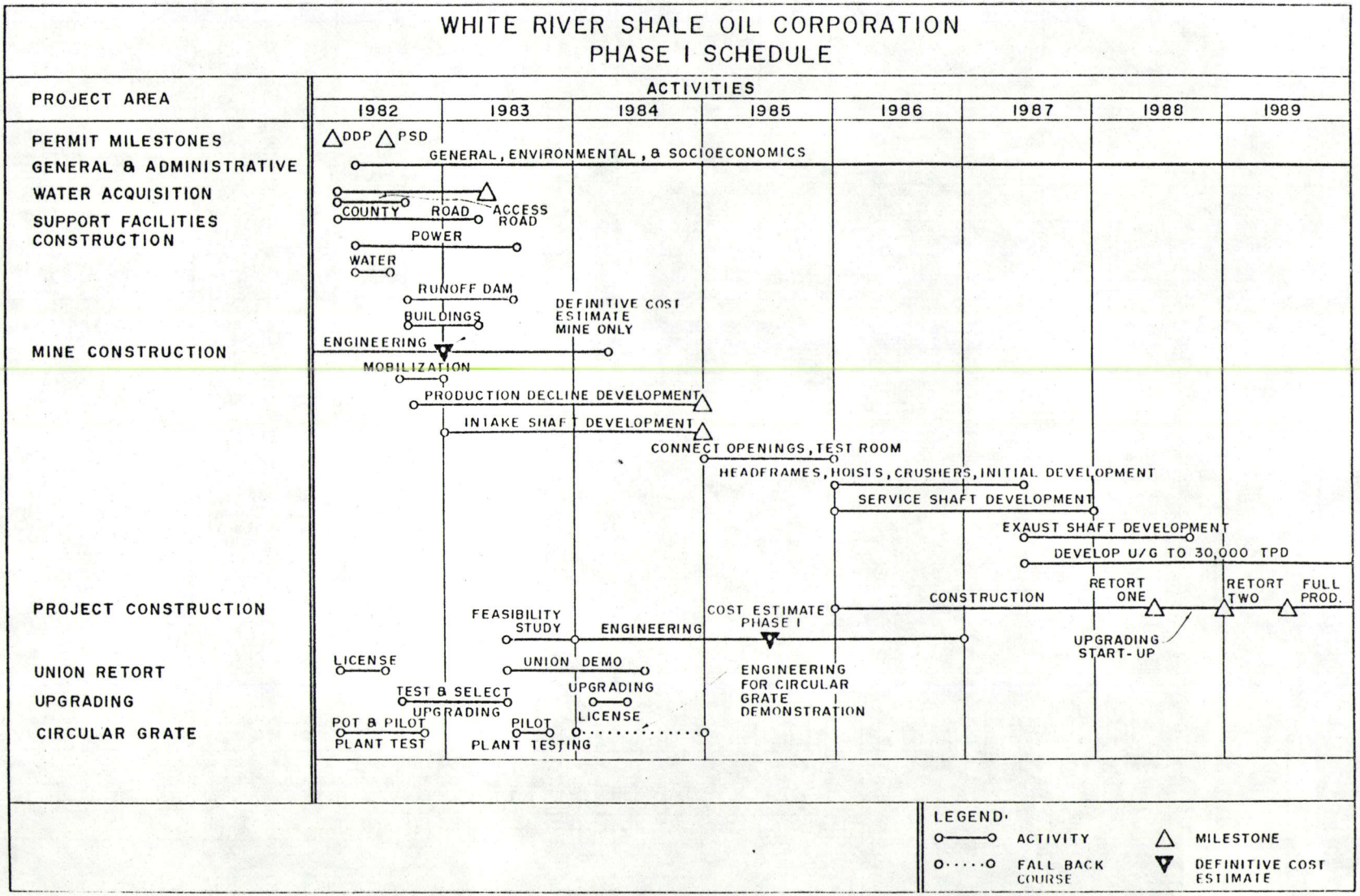


WHITE RIVER SHALE PROJECT
PHASE 1 PRODUCTION DECLINE & AIR INTAKE SHAFT



WHITE RIVER SHALE PROJECT
PHASE 1 SITE PLAN

WHITE RIVER SHALE OIL CORPORATION
PHASE I SCHEDULE



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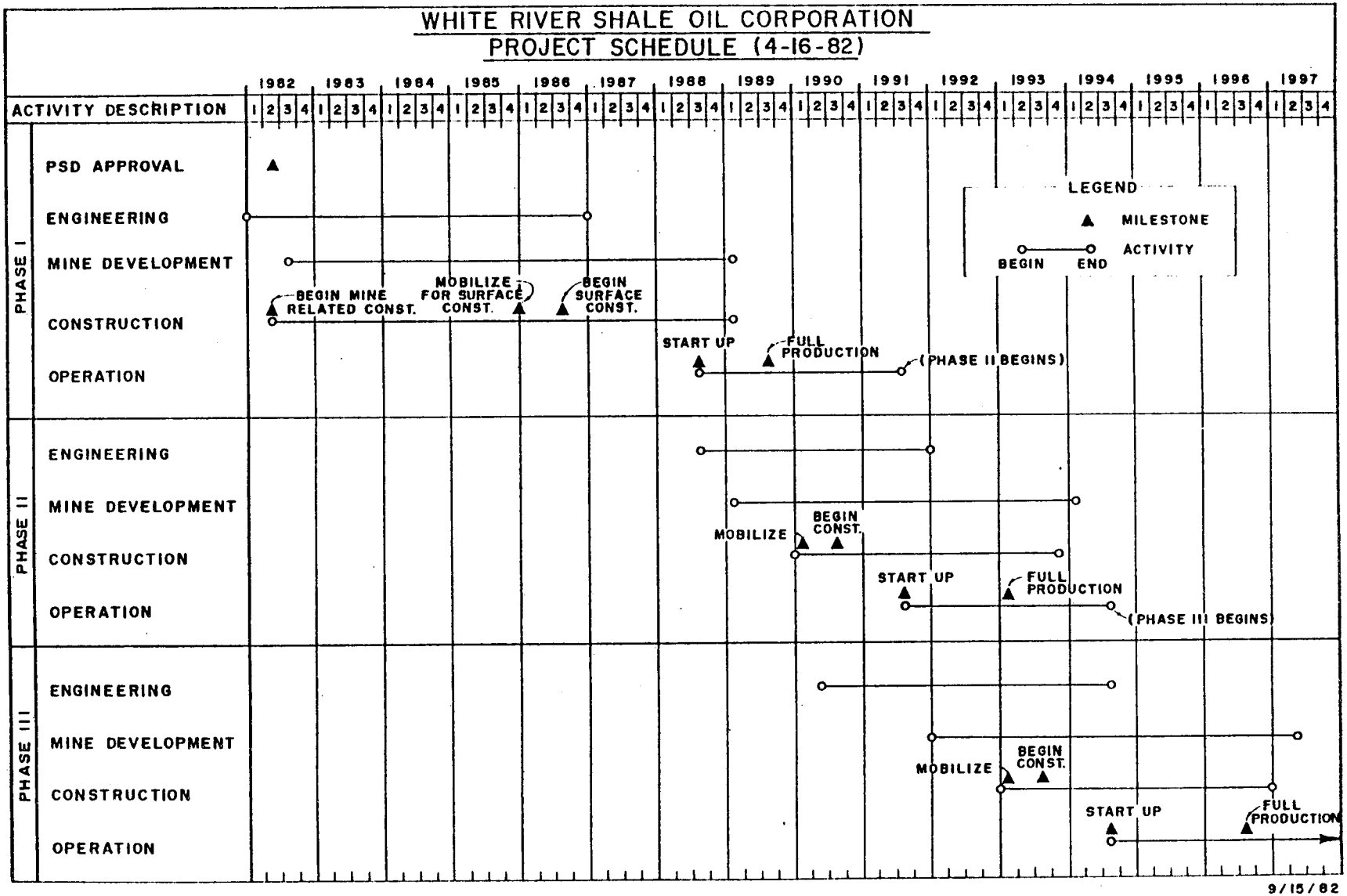
WHITE RIVER SHALE OIL CORPORATION
PROJECT SCHEDULE (4-16-82)



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154

THE GEOLOGY OF OIL SHALE TRACTS Ua AND Ub

PHYSIOGRAPHY

Tracts Ua and Ub are located in the eastern part of the Uinta Basin of Utah, a broad, asymmetric basin located on the northeastern edge of the Colorado Plateau. Lacustrine sediments of a prehistoric lake basin dominate the stratigraphy of the Uinta Basin. Major land features bordering the basin are the Uinta Mountains on the north, the Wasatch Range on the west, the Roan Cliffs on the south, and the highlands associated with the subsurface Douglas Creek Arch along the eastern edge.

Tracts Ua and Ub are bounded by the White River to the north, Hells Hole Canyon to the east, upland areas of elevations between 6,000 and 6,200 feet to the south, and Asphalt Wash to the west. The region near the tracts, including all the area extending southward to the Roan Cliffs and westward to the Green River, is a gently northsloping, highly dissected plateau, characterized by steep-walled canyons with ephemeral streams or dry washes that are subject to occasional flash floods. The relief of these canyons averages 30 to 50 feet, but in some places is as much as 1,000 feet.

Geomorphology

In the southeastern portion of the Uinta Basin, intertributary divides between major drainages are broad and capped by resistant rock strata. These strata dip northwestward a little more steeply than does the plateau surface itself to create narrow, benchlike mesas, cuestas, and hogbacks. Within Tracts Ua and Ub, the

landscape is composed of a series of north- and south-trending valleys separated by narrow, elongated mesas. There are three dominant ridge sections that trend just west of north, north, and just east of north as one proceeds from east to west across the tracts. The general direction of these landforms is perpendicular to that of the White River.

Physical weathering processes on Tracts Ua and Ub include frost action and mass wasting. Chemical weathering by solution, oxidation, and carbonation is also an important phenomonen. Downslope drainage results in colluvium deposits on slopes and the piling of debris upgradient form vegetation established on slopes. Gully erosion is also prevalent. Large amounts of sediment are picked up by water flowing down Asphalt Wash, Southam Canyon, and Evacuation Creek during occasional high-intensity summer thunderstorms. Erosion of dirt roads that parallel or traverse sections of these channels and their tributaries further contributes to the sediment load.

There is a greater diversity of ground slope gradients on Tract Ua than on Tract Ub, and the slopes found within Tract Ub are more gentle. The steepest slopes on the tracts are found adjacent to Evacuation Creek as it flows through Tract Ub, along the northwest-trending ridge that lies in the west portion of Tract Ua, within the southeast corner of Tract Ua, and in the southwest portion of Tract Ub. Channel cutting along the White River has also created steep slopes near the borders of both tracts. The

gentlest slopes occur on the mesa tops that lie parallel to and along Evacuation Creek, in northern portions of Tract Ub, and in sections of the eastern portions of Tract Ub. Level to gently sloping land is found in the south and southwest portions of Tract Ua.

Geologic structure and erosion have influenced the development of several landforms on the tracts, especially rock pinnacles and balanced rocks. These numerous and prominent forms occur on or near ridgetops. They have been developed by progressive erosion from drainages along vertical fractures or joints. Over long periods, this process leaves large isolated standing blocks of rock, whose development is enhanced by the presence of a more resistant caprock. In addition, large rock faces on canyon walls along the White River plainly show evidence of massive rock failures. These rock failures have occurred along vertical fractures that are generally perpendicular to the bedding.

Drainage Basin Form and Process

The overall drainage pattern of the Uinta Basin is predominantly dendritic, but because of the influence of the northwest-trending and northeast-trending sets of joints in the surficial rock formations, there are many straight reaches along stream channels. Larger streams of the basin have well developed, meandering channels within their relatively straight, steep-walled flood channels. Level portions of land near the river exhibit a fine-textured drainage density, while upland areas of the Uinta

Formation remain relatively undissected. Surficial outcrops of the Parchute Creek Member of the Green River Formation have a higher drainage density than the Uinta Formation.

GEOLOGIC HISTORY

In its early stages of formation, during the Paleocene Epoch, the Uinta Basin was the northeastern portion of a much larger intermontane lake basin that spread over most of Utah. Beginning with the Early Eocene Epoch, Lake Uinta covered the entire Uinta and Piceance Creek Basins and possibly connected with another large lake that covered most of southwestern Wyoming. By the close of middle Eocene time, this lake basin had dried up after accumulating a thick sequence of deep sediments from the surrounding highlands to form the present figuration of the Uinta Basin.

Sequences of strata that crop out in this region reflect the different stages of evolution of the basin. When Lake Uinta existed in its maxiumum dimensions, the Green River Formation sediments and organic matter accumulated on the lake bottom. As the lake diminished because of further rise of the Uinta Mountains and the Douglas Creek Arch, alluvial sediments of the Uinta Formation were deposited over the surface of the Uinta Basin by meandering streams.

STRATIGRAPHY

Green River Formation

The Green River Formation is an Eocene Series that consists primarily of light-gray to dark-gray, hard, brittle marlstone and

oil shale, interbedded with relatively minor amounts of brown sandstone, siltstone, nahcolite nodules, and thin volcanic tuff beds. Total thickness of the formation beneath the tracts is about 1,600 feet. The uppermost portion of the Green River Formation is exposed along Evacuation Creek and in the far northeastern edge of Tract Ub. Bradley described in detail the origin and occurrence of the Green River Formation. More recent work has led to a revised subdivision and nomenclature for the members of the Green River Formation. These members are listed and described in ascending stratigraphic order in the following paragraphs.

Douglas Creek Member. Compared with other parts of the Green River Formation, the Douglas Creek Member consists largely of sandstone and limestone, some marlstone, and only a small amount of oil shale. Outcrops of the Douglas Creek Member in Hells Hole Canyon just east of the tracts and in Evacuation Wash just southeast of the tracts reveal that the member is composed primarily of light-yellowish-brown and light-gray oolitic limestone interbedded with gray-to-brown sandstone and siltstone. This member is not exposed at the surface within the tracts, but lies below depths ranging from approximately 1,250 and 1,750 feet. Maximum thickness attained by this member beneath the tracts is about 650 feet.

Garden Gulch Member. The Garden Gulch Member consists primarily of gray and brown marlstone strata containing imbedded organic

matter and minor amounts of siltstone, sandstone, and thin beds of oil shale. This member is not exposed on the tracts, but is found below depths ranging from about 800 to 1,250 feet. Its thickness varies from 220 to 250 feet beneath the tracts.

Parachute Creek Member. The Parachute Creek Member includes the uppermost strata of the Green River Formation, and contains the most economically important sequences of oil shale strata within the Green River Formation. Its lithology is predominantly calcium carbonate mudstone, or marlstone, and dolomite, containing abundant organic matter interbedded with minor amounts of siltstone, sandstone, and altered volcanic tuff beds. Near the tracts, outcrops along the southeast perimeter of the Uinta Basin attain a maximum thickness of 900 feet, and, like the other Tertiary formations in the Uinta Basin, thicken progressively in the subsurface from the vicinity of the tracts toward the northwest. Strata within the upper 200 feet of the Parachute Creek Member are exposed within the eastern portion of the tracts. Most of the member, however, lies below the surface within the tracts. Thickness of the member averages 730 feet beneath the tracts.

The Mahogany Marker, a persistent and widespread key bed within the Parachute Creek Member, is an analcitized volcanic tuff bed that averges 6 inches in thickness, and lies 9 to 15 feet above the Mahogany Bed that contains the richest oil shale beds in the Basin. The Mahogany Marker weathers to orange-brown rectangular

blocks, whereas the Mahogany Bed outcrops as a light-gray-to-tan resistant ledge. This marker dips at about 150 to 200 feet per mile to the northwest. The Mahogany Oil Shale Bed averages about 100 feet in thickness beneath the tracts, and, as reported by the Geologic Exploration Program Report prepared for White River Shale Project by Cleveland-Cliffs, the proposed mining zone will extend from abut 20 feet above to 40 feet below the Mahogany Marker.

A remarkably distinctive zone lies near the top of the Parachute Creek Member and is known informally as the "Bird's Nest Zone" because of its many ellipsoidal cavities formed by the leaching out of nahcolite, a soluble sodium-bicarbonate mineral, from a matrix of predominantly siltstone and marlstone. This zone is the principal aquifer above the Mahogany Zone in the vicinity of the tracts.

A prominent ledge-forming light-brown sandstone unit that lies immediately above the Bird's Nest Zone is believed to be, according to Cashion, the Horse Bench Sandstone Bed. In the vicinity of the tracts, the Horse Bench Sandstone Bed varies from about 2 to 10 feet in thickness. Along Evacuation Creek within the tracts, this unit is composed of very fine sandstone and siltstone. Surface exposures of the Horse Bench Sandstone Bed are typically covered with white salt deposits, thereby suggesting groundwater seepage and evaporation from the outcrops.

Uinta Formation

The Uinta Formation, which overlies the Green River Formation, includes the most extensively exposed array of strata in the central Uinta Basin. Like the Green River Formation, the Uinta Formation is of Eocene age. Within Tracts Ua and Ub, the Uinta Formation crops out extensively and in places attains a maximum thickness of about 1,000 feet. The formation has been divided by previous investigators into two units, Unit a and Unit b, based primarily upon the position of a tuffaceous sandstone bed approximately 2 to 6 feet thick that lies at the base of Unit b. Unit a extends downward from the base of Unit b to the top of the Green River Formation. The lithology of both units is generally much the same: stream-deposited, fine-grained, light-reddish-brown sandstone and siltstone interbedded with minor amounts of shale and conglomerate.

Quaternary Alluvium

Within Tracts Ua and Ub, quaternary alluvium occurs along Evacuation Creek Canyon, within Southam Canyon, along the White River, and also in some isolated patches along drainages where these drainages pass over outcrops of the Uinta Formation.

The Southam Canyon alluvium is composed primarily of light-reddish-brown silt and fine sand and attains an estimated maximum thickness of about 40 feet. In the southern portion of Southam Canyon at Well Site AG-7, the alluvium is 37 feet thick. Alluvium in Evacuation Creek Canyon occurs in patches that reach maximum

thickness along the inside and downstream portions of meander loops of the creek. Estimated maximum thickness of all alluvium along Evacuation Creek Canyon is 21 feet. Since this canyon is being formed by erosion down through the Uinta Formation and into the Green River Formation, the alluvium is composed predominantly of a mixture of coarse-grained, platy marlstone fragments, fine-to-medium sand, and sand-sized limestone fragments. Isolated patches of alluvial material that have been deposited on outcrops of the Uinta Formation are basically light-reddish-brown fine silty sand. Along the White River, the alluvium is primarily light-brown fine sand with some gravel. The maximum thickness of the alluvium along the White River near the tracts is about 35 to 50 feet.

STRUCTURAL GEOLOGY

Geologic structure within the vicinity of the site is quite uniform. The strata generally dip less than 5 degrees (below horizontal) toward the north or northwest, and no surface expression of faulting is exhibited. The Mahogany Marker bed reveals the orientation of strata within the proposed mining zone and generally dips about 150 to 200 feet per mile toward the northwest.

A surface examination has revealed several sets of near-vertical joints (rock fractures) occurring throughout the site area. Since the joints are very important in the overall strength and stability of the strata, they have been mapped and analyzed in

detail. The primary set of joints within the entire site area trends north 62 degrees west and dips 86 degrees toward the southwest. Three secondary sets are also present, trending north 22 degrees east, north 18 degrees east, and north 33 degrees east, with dips that are respectively 88 degress northwest, 88 degrees southeast, and 87 degrees southeast. The character of the joints that are formed in the Uinta formation is, as a rule, quite changeable. Smooth, large, flat, open joints are the most noticeable in the field; however, there are also numerous small, rough, closed joints in outcrop exposures throughout the area.

Two inclined core holes were drilled on the tracts to investigate the occurrence of steeply dipping subsurface joints or fractures. Information obtained from the drilling of these two inclined holes, combined with the previous information obtained from vertical drill holes, indicates that the subsurface material comprising the lower part of the Uinta Formation and the upper part of the Green River Formation is competent. Frequent parting planes parallel to the bedding are present, particularly in the leaner shale zones, but steeply dipping joints or fractures are rare. Some of these fractures are marked by an accumulation of gilsonite, a seepage product of the shale oil. GEOLOGIC HAZARDS

Seismicity

Seismic risk is defined as the probability of earthquake damage from ground shaking, subsidence, differential settlement, ground

cracking, or liquefaction. Three zones of seismic risk, based on historic earthquake occurrence, have been identified for the western U.S. Tracts Ua and Ub lie within the lowest risk zone. No active surface faults have been reported in the vicinity of the tracts.

Landslides and Rockfalls

Ancient landslides are evident along many of the steep cutbanks of the White River. Examples of recent debris flows within steep drainages and rockfalls along sharp ridges are evident on the tracts. Severe thunderstorms and accompanying flash floods are the primary forces causing landslides and debris flows.

MINERAL RESOURCES

Oil and Natural Gas

Altogether, there have been eight holes drilled for oil and gas exploration on Tracts Ua and Ub. Only one of these holes, located in the central portion of Tract Ua within Southam Canyon, has produced economically valuable quantities of oil and gas. The other on-tract exploratory holes were dry. However, a group of about 14 productive gas wells have been completed approximately 4 to 5 miles southwest of Tract Ua. Another three productive gas wells are 1.5 to 3 miles southwest of Tract Ua. Although these wells penetrate the entire thickness of the Eocene strata, the principal productive zone (the Mesa Verde Formation of Cretaceous age) lies considerably deeper in the section.

Oil Shale

Oil shale is not shale at all, but is actually a dense, tough, thinly bedded, dark-to-olive-brown to brownish-black marlstone. The organic fraction of oil shale was derived from microorganisms that origianlly flourished in shallow tropical lakes and from pollen, spores, and fragments of land plants blown into the ancient lake system. The inorganic fraction of the oil shale is composed mainly of dolomite and calcite, with minor amounts of quartz, feldspars, analcite, clay, and pyrite. Analysis also indicates the presence of boron, mercury, cadmium, fluoride, antimony, arsenic, and selenium in trace amounts. Cashion defined oil shale as marlstone that will hield at least 15 gallons per ton.

Gilsonite

Classed as an asphaltite, Gilsonite is a black, tar-like, brittle substance which has been formed as a residue of natural petroleum. Homogeneous veins of Gilsonite occur along straight and continuous northwest-trending joints and minor faults in the east-central Uinta Basin, primarily within the Uinta Formation.

Other Resources

Other economic and potentially economic mineral resources found in the Uinta Basin include bituminous sandstone, coal, uranium, gypsum, and nahcolite. None of these have been identified as being present in any commercial quantities on the tracts. Only small quantities of contstruction-grade sand and gravel are present on the tracts for use in construction.